RDR-3200 (Panasonic Gyro) User Manual

Version 1.0

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Prepared by
RoyalTek Company LTD.

4F, No. 188, Wen Hwa 2nd Rd.,
Kuei-Shan, Tao-Yuan 333, Taiwan
TEL: 886-3-3960001
FAX: 886-3-3960065

Website: http://www.royaltek.com
Email: http://www.royaltek.com/contact

Content

1. Introduction

RoyalTek RDR-3200 is the newest generation of RoyalTek GPS module integrated Dead Reckoning technology. The RDR-3200 includes dead reckoning sensors to track your vehicle's course when your GPS signal is blocked for example in urban areas or tunnels. If you lose GPS coverage in areas with tall buildings or tunnels, the RDR-3200 keeps on navigating.

This document describes the recommended schematic and layout design of gyro and odometer circuit, and is designed to operate with RDR-3200 algorithm correctly. This document also describes the application of DR protocol and illustrates how to optimize the performance of DR using known digital map information.

2. Product Feature

- ✧ 20 parallel channels
- ✧ Screw holes type
- ✧ Newest generation of RoyalTek GPS module integrated Dead Reckoning technology
- ✧ Keep on producing an accurate position after loosing contact to the GPS satellites.
- ✧ Enhanced algorithm for navigation stability and minimizes the effects of GPS outages, And provide improved position accuracy in urban environments.
- ✧ Excellent sensitivity for urban canyon and foliage environments.

2.1 Product Applications

- ✧ Automotive navigation

3. Specification

GPS Chipset	- Star III GPS Gsc3f/LPX chipset
Frequency	- L1 1,575.42 MHz
Channel	- 20 channels
C/A Code	- 1,023 MHz
chipset Fix time (Open sky)	- Reacquisition: less than 0.1s - Hot start: 1 sec - Warm start: 35 sec - Cold start: 35 sec
Accuracy	- Position: within 10m for 90% - Velocity: 0.1m/s
Interface Protocol	- NMEA 0183
DGPS	- Default is Disable
WAAS	- Default WAAS is Disable
Altitude	- 18,000 meter maximum
Velocity	- 514 meter/second maximum
MCU	- Silicon Lab C8051F353
Antenna	
Active Antenna RF Connector	- SMA R/A PCB JACK (J1) - Option for any kind of RF Connector
External Antenna input Voltage	- Recommend using 2.7V~3.3V
Power	
Voltage Type	- DC +5V ± 2%
Screw Hole type	
Antenna Detect function	
	GPIO; Follow customer GPS antenna detector protocol Port 2 baud Rate: 38400bps 1: YES / 0:NO
Interface	
Connector	20 Pin Header，2.0 mm pitch (J2) Male seat
Physical and Environment	
Dimension	- 71±0.3mm(L) x 40.8±0.3mm(W) x 18.3mm±0.3mm (H)
Weight	- ≦19.6(g)
Temperature	- Operating: -40 ~ 85℃ - Storage: -40 ~ 85℃

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4. Reference design of Gyro and Odometer circuit design

4.1 System Block Diagram (Panasonic SKU)
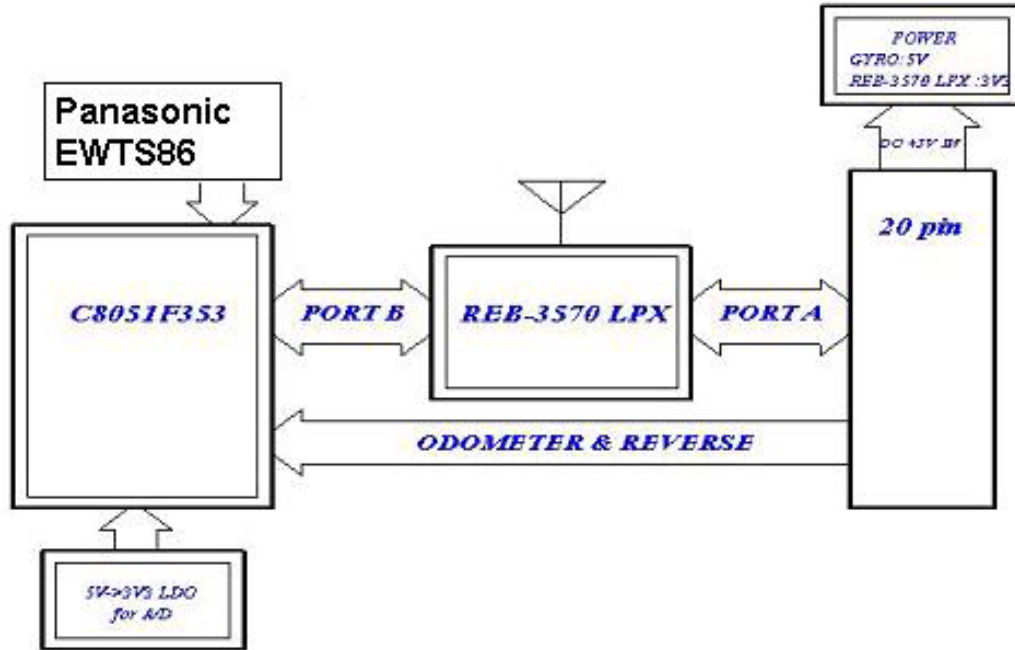
4.2 Application Circuit

Figure 1 illustrates the proposed schematic diagram of Gyro, odometer and RDR-3200. RDR-3200 supports the Gyro, Panasonic. Please care about the ground partition design among Gyro circuit, RDR-3200 and odometer input. It would be better to use 2 kinds of ground.

The input of odometer is around 12V typically. It transfers the voltage level to accommodate the I/O voltage level of RDR-3200. The photo coupling transistors also isolate the noise of car from the RDR-3200 system.

The power of the gyro is 5Vwhich is different from the power of RDR-3200. Please use a separate analog ground for gyro. And please keep high speedy signal away from the signal path of gyro and power when doing layout.
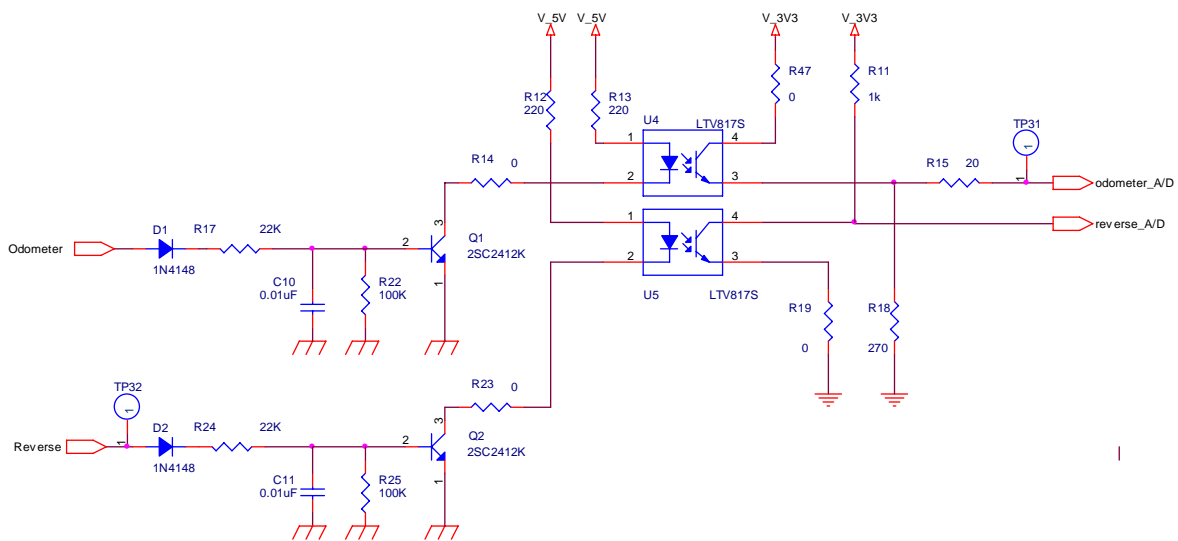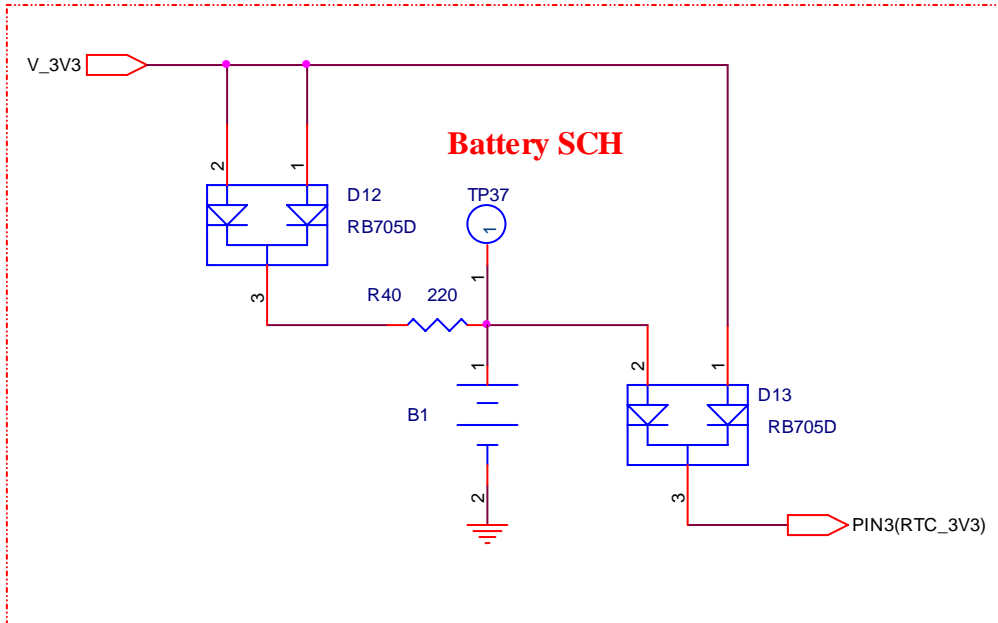
Figure 1.

Odometer/Reverse Circuit

Figure 2.

Backup Battery Circuit

Battery SCH

5. Interface

5.1 Connector Type：20 Pin Header，2.0 mm pitch (J2)

Pin NO	Signal Name	I/O	Description	Characteristics
1	N.C		None connector	
2	GPS 5V	I	+5V DC Power Input	DC +5V ± 5%.
3	RTC (Backup voltage)	I	User Supply DC +2.6 ~ +3.6V	DC +2.6 ~ +3.6V. Current ≤ 10uA w/o battery
4	GPS 5V	I	+5V DC Power Input	
5	Reset	I	Reset (Active low)	$V_{IH} > 2.3V$ $V_{IL} < 0.8V$
6	Boot	I	Boot mode	$3.15 \geq V_{IH} \geq 1.995V$ $-0.3V \leq V_{IL} \leq 0.855V$
7	Back (Reverse)	I	Forward or Back	Forward (Hi level :>2V) Backward (Lo level: <0.8V)
8	N.C		None connector	
9	Odometer	I	Odometer	Input frequency<4k HZ Vih > 2V Vil<0.8V
10	GND	G	Ground	Reference Ground
11	TXD1 (SiRF 3 TXD1)	O	NMEA (transmit) Car PC (UAR1) 4800bps, 8 data bits, no parity, 1 stop bit	$2.85V \geq V_{OH} \geq 2.375V$ $V_{OL} \leq 0.715V$
12	RXD1 (SiRF 3 RXD1)	I	NMEA (Receive) Car PC (UAR1)	$3.15V \geq V_{IH} \geq 1.995V$ $-0.3V \leq V_{IL} \leq 0.855V$
13	GND	G	Ground	Reference Ground
14	TXD2 (SiRF 3 TXD2)	O	Can bus data (transmit) Car PC (UAR2)	Vih > VDD-0.1V Vil<0.6V VDD:3.3V for MCU
15	RXD2 (SiRF 3 RXD2)	I	Can bus data (Receive) Car PC (UAR2)	Vih > 2V Vil<0.8V
16	GND	G	Ground	Reference Ground
17	GND	G	Ground	
18	GND	G	Ground	Reference Ground
19	N.C		NC	
20	N.C		NC	

GPS_5V

This is the DC power supply input pin for system. .

GND

GND provides the reference ground .

BOOT

Set this pin to high for programming flash.

RXD1

This is the main receiver channel and is used to receive software commands to the board from SIRFdemo software or from user written software.

RXD2

This is the auxiliary receiving channel communicated with car pc with can bus

TXD1

This is the main transmitting channel and is used to output navigation and measurement data to SiRFdemo or user written software.

TXD2

This is the auxiliary transmitting channel communicated with car pc with can bus

ODOMETER

This pin provides for connecting to odometer.

RTC (Backup voltage)

This is the battery backup input that powers the SRAM and RTC when main power is removed. Typical current draw is 10uA.

The supply voltage should be between 2.5V and 3.6V.

BACK (Reverse)

This pin provides for connecting to backward signal.

Reset

This pin provides an active-low reset input to the board. It causes the board to reset and start searching for satellites. If not utilized, it may be left open.
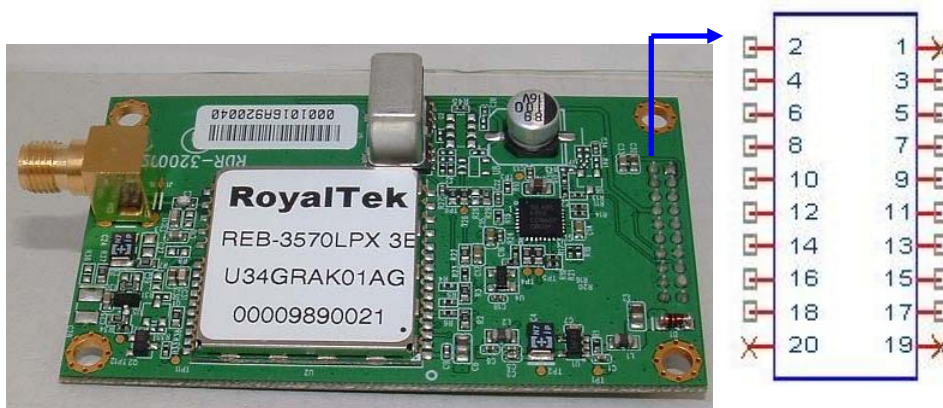
5.2 RF connector type: SMA R/A PCB JACK (J1)

RF IN:

This pin receives GPS analog signal. The line on the PCB between the antenna (or antenna connector) has to be a controlled impedance line (Microstrip at 50Ω). This pin can provide maximum power 30mA @ 2.85V for active antenna.

6. Product Picture

TOP:

Bottom:

7. Mechanical Layout

External Active ANT

Units: mm

Pin Header/Pitch 2.0mm
10Px2 180°
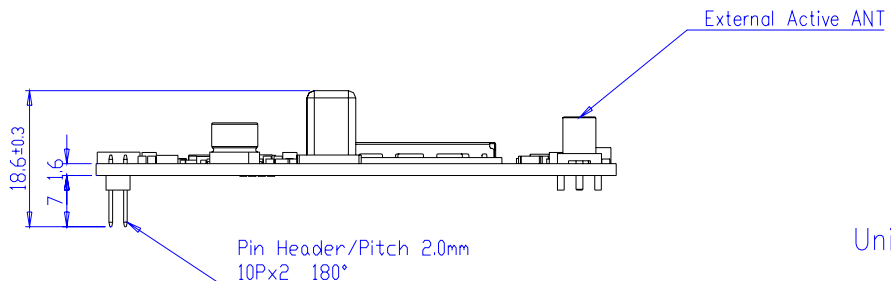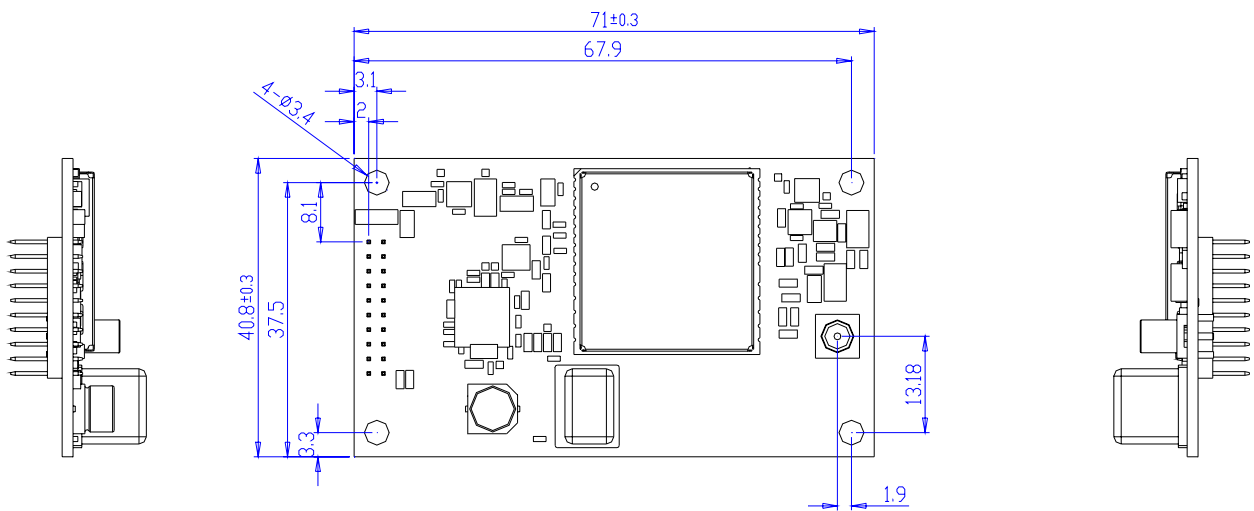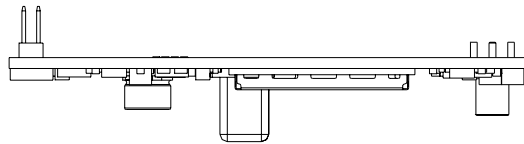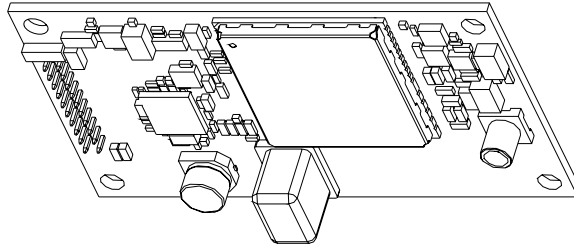
8. SW Protocol

8.1 GPS output Protocol

The communication settings:

      Baud rate: 38400, n, 8, 1

The UARTA will output GPS NMEA 0183 V3.0 protocol and RoyalTek DR protocol. There are 4 type sentence will output as the follow table:

Table 1-1 NMEA-0183 Output Messages

NMEA Record	Description
GGA	Global positioning system fixed data
GSA	GNSS DOP and active satellites
GSV	GNSS satellites in view
RMC	Recommended minimum specific GNSS data

The RoyalTek DR protocols are NMEA like protocol to show the DR navigation and calibration information.

8.1.1 RoyalTek DR protocol – RTOEM,3

This sentence contains the navigation and calibration information of DR.
The protocol is illustrated as follows:

Item	Field	Description
1	$	Beginning of sentence
2	RTOEM	Message Header
3	3	Message ID
4	GPS validated	Number of SV in use > 3 = 1, other is 0
5	Gyro Bias Initial Status	1.Success, 0: Failed
6	Odometer Scale Initial Status	1: Success, 0: Failed
7	Gyro Input Status	1: Available, 0: no input
8	Odometer Input Status	1: Available, 0: no input
9	Sensor Capture Count	The count of data read count from MCU
10	Odometer Input Source	1: CAN BUS,0: Vehicle's Odometer PWM
11	DR Status	4: Initialize, 3: GPS Mode, 2:DR Mode
12	Backward Status	1: Activated / 0: Normal
13	Antenna Detecting	1: Available / 0: Abort
14	Gyro Input Voltage	Current Gyro Input voltage and scale is 500:1
15	EKF Odometer scale	The scale factor of odometer pulse. The scale is cm/pulse

16	Delta Angle	Vehicle's Cog per second (unit = degree), +: turn right, '-': turn left.
17	Odometer/CAN Bus Pulse Count	The pulse count of last second of odometer sensor. The unit is pulse / second.
18	Delta Distance	The delta distance of last second. (unit=meter)
19	Map Matching Status	1: Received and executed a map matching sentence; 0: Not receive any map matching sentence.
20	*CC<CR><LF>	Check Sum and sentence termination delimiter. The algorithm of checksum calculation is same with the one to calculate NMEA checksum.

Example:

$RTOEM,3,1(X1),1(X2),1(X3),1(X4),1(X5),1(X6)0(X7)3(X8)0(X9)1(X10),831.95(X11),

29.78(X12),27.45(X13),77(X14),22.93(X15),0(X16) *50

X1: GPS is validated.

X2: Gyro bias is initialized

X3: Odometer scale is initialized

X4: Gyro input source is available

X5: Odometer input source is available

X6: 1 time for capture sensor per

X7: Odometer source is used

X8: GPS mode is used

X9: No backward is captured

X10: Antenna is available

X11: Gyro voltage is 831.95 / 500 = 1.6639 (V)

X12: EKF odometer scale parameter is 29.78 (cm/pulse)

X13: Delta angel for Device is turn right 27.45 (degree)

X14: Odometer capture pulse count is 77

X15: Delta Distance for Device is 22.93 (meter)

X16: No MMF command is accepted

8.1.2 GGA-Global Positioning System Fixed Data

Table 1-3 contains the values of the following example:

$GPGGA,161229.487,3723.2475,N,12158.3416,W,1,07,1.0,9.0,M, , , ,0000*18

Table 1-1 GGA Data Format

Name	Example	Units	Description
Message ID	$GPGGA		GGA protocol header
UTC Position	161229.487		hhmmss.sss
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		Dddmm.mmmm

E/W Indicator	W		E=east or W=west
Position Fix Indicator	1		See Table 1-4
Satellites Used	07		Range 0 to 12
HDOP	1.0		Horizontal Dilution of Precision
MSL Altitude	9.0	meters	
Units	M	meters	
Geoid Separation		meters	
Units	M	meters	
Age of Diff. Corr.		second	Null fields when DGPS is not used
Diff. Ref. Station ID	0000		
Checksum	*18		
＜CR＞＜LF＞			End of message termination

Table 1-2 Position Fix Indicators

Value	Description
0	Fix not available or invalid
1	GPS SPS Mode, fix valid
2	Differential GPS, SPS Mode, fix valid
3-5	Not Supported GPS PPS Mode, fix valid
6	Dead Reckoning Mode, fix valid

8.1.3 GSA-GNSS DOP and Active Satellites

Table 1-5 contains the values of the following example:
$GPGSA,A,3,07,02,26,27,09,04,15, , , , , ,1.8,1.0,1.5*33

Table 1-1 GSA Data Format

Name	Example	Units	Description
Message ID	$GPGSA		GSA protocol header
Mode 1	A		See Table 1-6
Mode 2	3		See Table 1-7
Satellite Used	07		Sv on Channel 1
Satellite Used	02		Sv on Channel 2
….			….
Satellite Used			Sv on Channel 12
PDOP	1.8		Position Dilution of Precision
HDOP	1.0		Horizontal Dilution of Precision
VDOP	1.5		Vertical Dilution of Precision
Checksum	*33		
＜CR＞＜LF＞			End of message termination

Table 1-2 Mode 1

Value	Description
1	Fix not available
2	2D
3	3D

Table 1-3 Mode 2

Value	Description
M	Manual-forced to operate in 2D or 3D mode
A	Automatic-allowed to automatically switch 2D/3D

8.1.4 GSV-GNSS Satellites in View

Table 1-8 contains the values of the following example:

$GPGSV,2,1,07,07,79,048,42,02,51,062,43,26,36,256,42,27,27,138,42*71

$GPGSV,2,2,07,09,23,313,42,04,19,159,41,15,12,041,42*41

Table 1-8 GSV Data Format

Name	Example	Units	Description
Message ID	$GPGSV		GSV protocol header
Number of Messages[1]	2		Range 1 to 3
Messages Number[1]	1		Range 1 to 3
Satellites in View	07		
Satellite ID	07		Channel 1(Range 1 to 32)
Elevation	79	degrees	Channel 1(Maximum 90)
Azimuth	048	degrees	Channel 1(True, Range 0 to 359)
SNR (C/No)	42	dBHz	Range 0 to 99, null when not tracking
….			….
Satellite ID	27		Channel 4(Range 1 to 32)
Elevation	27	degrees	Channel 4(Maximum 90)
Azimuth	138	degrees	Channel 4(True, Range 0 to 359)
SNR (C/No)	42	dBHz	Range 0 to 99, null when not tracking
Checksum	*71		
＜CR＞＜LF＞			End of message termination

[1]Depending on the number of satellites tracked multiple messages of GSV data may be required.

8.1.5 RMC-Recommended Minimum Specific GNSS Data

Table 1-9 contains the values of the following example:
$GPRMC,161229.487,A,3723.2475, N,12158.3416,W,0.13,309.62,120598,,,A*10

Table 1-1 RMC Data Format

Name	Example	Units	Description
Message ID	$GPRMC		RMC protocol header
UTC Position	161229.487		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	3723.2475		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12158.3416		dddmm.mmmm
E/W Indicator	W		E=east or W=west
Speed Over Ground	0.13	knots	
Course Over Ground	309.62	degrees	True
Date	120598		Ddmmyy
Magnetic Variation		degrees	
Variation sense			E=east or W=west(Not Shown)
Mode	A		A=Autonomous, D=DGPS, E=DR
Checksum	*10		

GPS DR (UART A) Input command

The input command is used to let the navigation program send command to DR.

8.2.1 $MMF

This MMF command is used to let the navigation program send the map matching information to the DR module to update the current position and azimuth angle of device using known information. Please refer to section 2.2 Calibration of DR using digital map information for further information.

$MMF, Delta_Latitude,A,Delta_Longitude,A,Delta_ Cog,A*ck<CR><LF>

Item	Field	Length	Description
1	$	1	Beginning of sentence
2	MMF	5	Message Header
3	Delta Latitude (ddddddd)	7	The correction of latitude value to calibrate DR position that generated by map. Value the unit is 1.0e-6 degree
4	A	1	A: use above value to calibrate the DR Latitude V: Do not use.
5	Delta Longitude (dddddddd)	8	The correction of longitude value to calibrate DR position that generated by map. Value the unit is 1.0e-6 degree
6	A	1	A: use above value to calibrate the DR Longitude V: Do not use.
7	Del_Cog	4	The correction angle (COG) of current movement to calibrate DR Heading that generated by map. Value the unit is 0.1 degree.
8	A	1	A: use above value to calibrate the DR Longitude V: Do not use.
9	*CC<CR><LF>	5	Check Sum and sentence termination delimiter. The algorithm of checksum calculation is same with the one to calculate NMEA checksum.

Example:
> Example:
> => If current DR position is (24.106928 N, 120.299588 E) with COG=213.19 degree
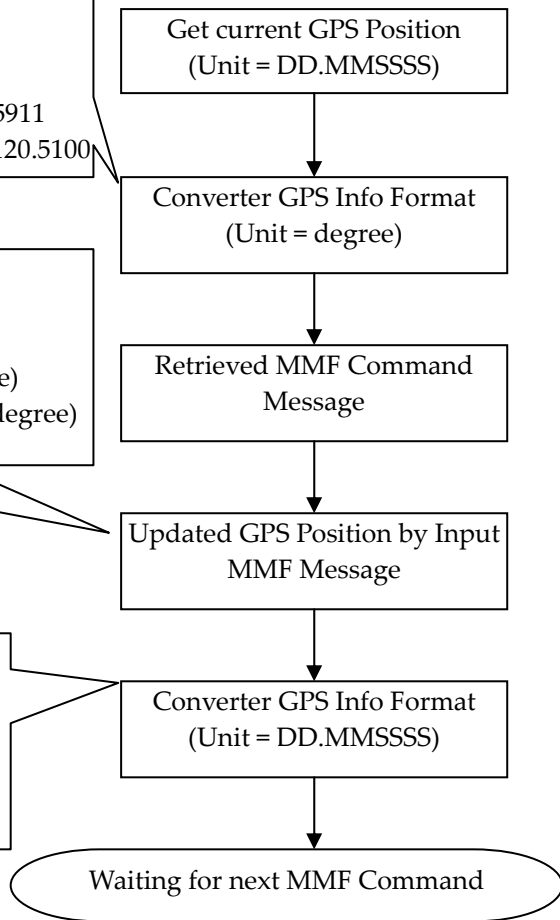> => $MMF,156,A,288,A,10,A*2D
> => It will set the DR position to (24.119842 N, 120.301837 E) with COG = 214.19 degree.

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Transfer Examples:
 Original: (24.106928,N,120.299588,E) (213.19)
 Result: (to unit = degree)
 Lat = 24 + 10/60 + 69.28/3600 (if S is used, Lat * -1.0) = 24.185911
 Long = 120 + 29/60 + 95.88/3600 (if S is used, Long * -1.0) = 120.5100

Command Description:
 Parameter: (156,A(para1),288,A(para2),10,A(para3))
 Exposition:
 If para1 = 'A', Lat = Lat(24.1859) + 156 * 0.000001(unit = degree)
 If para2 = 'A', Long = Long(120.5100) + 288 * 0.000001(unit = degree)
 If para3 = 'A', Cog = Cog(213.19) + 10 * 0.1

Description:
 Lat Format: DD.MMSSSS, N/S indicator
 (If lat value < 0.0, 'S' is used. Other is 'N')
 Long Format: DDD.MMSSSS, E/W indicator
 (If long value < 0.0, 'W' is used. Other is 'E')
 Cog: unit = degree

Get current GPS Position (Unit = DD.MMSSSS)

Converter GPS Info Format (Unit = degree)

Retrieved MMF Command Message

Updated GPS Position by Input MMF Message

Converter GPS Info Format (Unit = DD.MMSSSS)

Waiting for next MMF Command

8.3 CAN bus (UART B) protocol

The RDR-3100 provides a second port to receive the speed and reverse message from the input source. If the module receives the following input message then the DR module will stop reading the speed and reverse message from MCU.
The communication settings:

Baud rate: 38400, n, 8, 1

Update rate: 1 Hz

8.3.1 Speed, Reverse status input Message

This sentence contains the speed and reverse information that read from CAN bus. The protocol is illustrated as the following:

Item	Field	Description
1	$	Beginning of the sentence
2	PSRF121	Message Header
3	Speed	
4	Reverse	High-normal / Low - activated
5	*CC<CR><LF>	

Example:

Example:

$PSRF121, 100, 1*25

Speed = 100 * scaled meter/second

Reverse isn't activated

Checksum = 25

8.3.2 GPS antenna detection output Message

This sentence contains the GPS antenna detector information which read from GPS module and send to the CAN bus.

The protocol is illustrated as follows:

Item	Field	Description
1	$	Beginning of sentence
2	PSRF122	Message Header
3	GPS antenna status	1: antenna connected 0: antenna not connected
4	*CC<CR><LF>	Check Sum and sentence termination delimiter. The algorithm of checksum calculation is same With the one to calculate NMEA checksum.

Example:
$PSRF 122,1*3B<CR><LF>
GPS antenna connected
Check sum= 0x3B.

8.4 NMEA Output Message

9   Calibration of DR

9.1 Self calibration of DR

RDR-3100 calibrates the Gyro bias and odometer scale using the information of GPS satellites automatically. It also updates the position and azimuth using GPS navigation information automatically. Customer is not required to calibrate the Gyro bias and odometer scale factor. In respect to the position and azimuth angle, RDR-3100 DR provides a protocol, which is used to calibrate the position and azimuth angle using digital map.

9.2 Calibration Criterion

•Keep vehicle in static with 15 seconds at least after power on to retrieve gyro initial bias
•During normal operation, the calibration of gyro and odometer scale take place automatically during periods of good GPS reception. **9.3 Calibration of DR using**

digital map information

The DR is used to output the navigation data when GPS signal is absent or poor. The longer time of losing GPS signal, the Gyro precision and odometer would become worse. The best way to have better DR performance is to use the digital map information. Once the map matching completed, it could provide useful information for DR algorithm to continuously output the accurate navigation information as possible. The PROYRESET is designed for this purpose. Navigation application can reset the DR position and COG especially when no or poor GPS signal occurs. Because digital map provides very accurate and stable positioning information, to get longer and more accurate DR output, please use PROYRESET to achieve it.

9.4 Gyro Electric Characteristics

Gyro Chipset	- Panasonic EWTS86

Operation voltage Range	- +5±0.25 V
Temperature Range	- -40 ~ 85℃
Zero point voltage	- +2.5±0.4V
Sensitivity	- 25mV/(˚/S)
Frequency response(7Hz)	- >−4dB
Output voltage range	- 0.3~4.7V
Output noise	- <10mVpp

10. Package Specification and Order Information
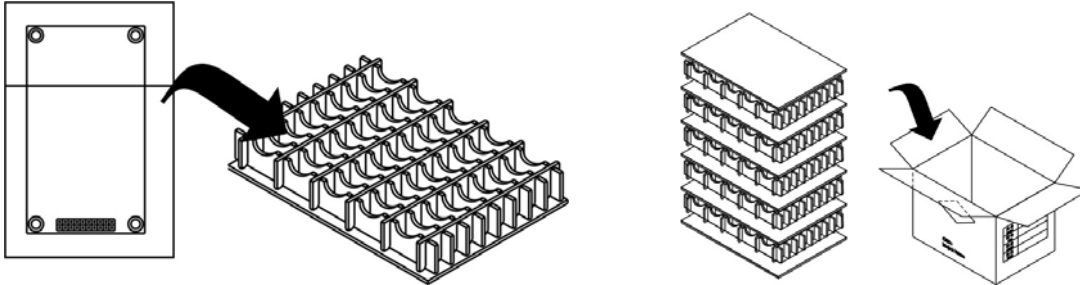
11. Contact Royaltek

Headquarter:

Address: 4F., No.188, Wen Hwa 2nd Rd., Kuei Shan, Tao Yuan 333, Taiwan

TEL: 886-3-3960001
FAX: 886-3-3960065

Web Site: http://www.royaltek.com

Web Site Customer Service: http://www.royaltek.com/contact

12. Revision History

Revision Number	Date	Author	Change notice
1.0	2009/06/02	May Chen	Initial Release